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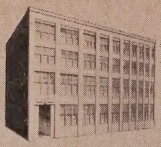

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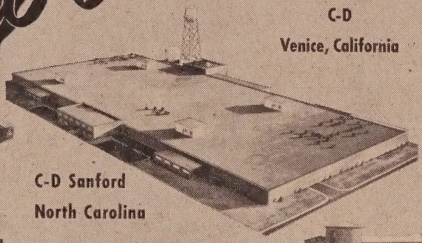

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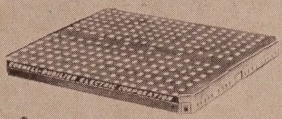

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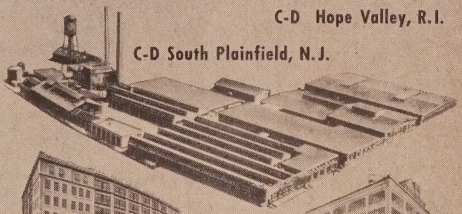

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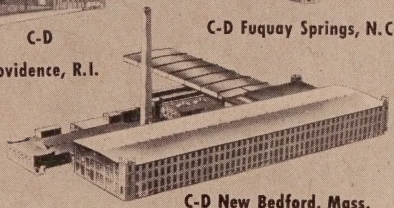

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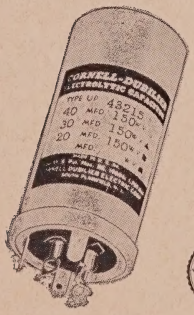

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SIMPLE METHODS OF MEASURING TRANSISTOR IMPEDANCES

By nature the transistor has the configuration of an active network. In the equivalent network, the impedances differ markedly in magnitude from comparable vacuum-tube impedances. Furthermore, certain of the transistor impedances have no counterpart in the tube.

A knowledge of the magnitude of each transistor impedance aids in the efficient transistorization of circuits. While the average values of these parameters and their spreads are obtainable from some manufacturers' literature, exact values for an individual transistor often are required and must be measured by the user.

Transistor test sets are offered by several instrument manufacturers. However, these complete instruments ordinarily are to be found only in laboratories doing the large amount of transistor work which would justify their cost. In all other instances, the circuit designer is expected to measure transistor impedances with conventional test equipment. This article discusses some of the methods which may be used.

Resistive Parameters

At low audio frequencies, the principal transistor parameters closely approximate the d-c resistive values. Sometimes, it is more convenient and always it is simplier to measure these d-c values.

When the equivalent circuit of the transistor is considered as a T-network (Figure 1), input, output, and transfer resistances are determined in terms of internal base resistance (r_b), collector resistance (r_c), and emitter resistance (r_e). To understand the methods of measurement, it is necessary to see how these internal resistances, or low-frequency impedances, in combination affect the magnitude of the input, output, and transfer resistances.

Since different pairs of transistor electrodes are used for input and output in common-base, common-emitter, and common-collector circuits, it is readily apparent that different internal resistances will be involved in the determination of the parameters. In highly-simplified form, **input resistance** (R_{11}) is equal approximately to r_e+r_b in the common-base and common-emitter circuits, and r_b+r_c for the common-collector. **Output resistance** (R_{22}) is approximately r_b+r_c in the common-base; r_c+r_e in the common-emitter and common-collector. **Forward transfer resistance** (R_{21})

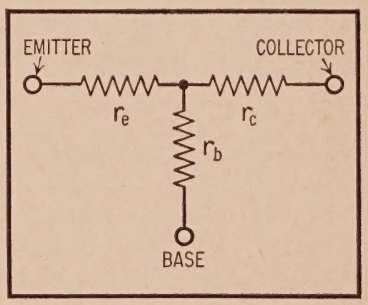

Fig. 1. Simplified 3-Terminal Equivalent of Transistor.

is approximately r_b+r_m for the common-base (where $r_m=ar_c$, a being the emitter-to-collector current amplification factor), r_e-r_m for the common-emitter, and r_c (1–a) for the common-collector. **Reverse transfer (or feedback) resistance** (R_{12}) is approximately r_b for the common-base,

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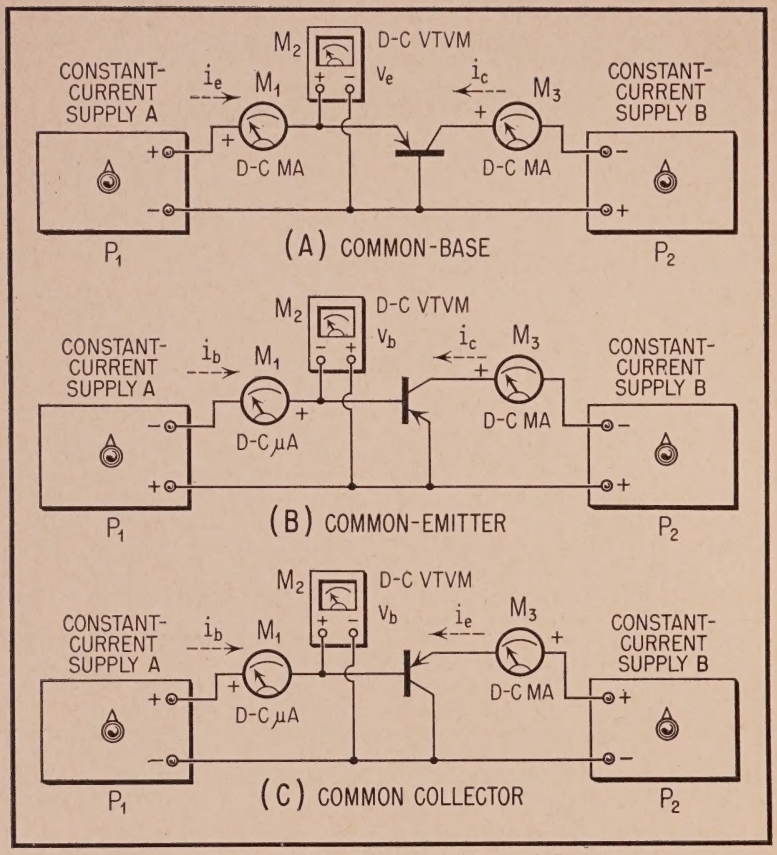

Fig. 2. Setups for Checking R_{11} and R_{12}.

r_e for the common-emitter, and r_c for the common-collector. Exact formulas may be obtained from transistor theory textbooks.

Measurement of Resistive Parameters

The resistive impedances may be measured with simple combinations of d-c vacuum-tube voltmeters, milliammeters or microammeters, and adjustable constant-current d-c supplies. In the following examples, the polarities shown are correct for PNP transistors. When checking NPN transistors, reverse the polarities of all meters and power supplies.

Input Resistance R_{11}. The test circuits are shown in Figure 2. In the common-base circuit (Figure 2A), emitter current i_e is varied while holding collector current i_c constant. The resulting emitter voltage v_e is indicated by the vtvm. A curve of v_e vs. i_e is plotted.

The slope of this curve is R_{11}. A family of curves may be plotted for various constant values of i_e.

In the common-emitter circuit (Figure 2B) and common-collector (Figure 2C), base current i_b is varied while holding collector current i_c constant. The resulting base voltage v_b is indicated by the vtvm. A curve of v_b vs. i_b is plotted. The slope of this curve is R_{11}. A family of curves may be plotted for various constant values of i_c.

Output Resistance R_{22}. The test circuits are shown in Figure 3. In the common-base circuit (Figure 3A), collector current i_c is varied while holding emitter current i_e constant. The resulting collector voltage v_c is indicated by the vtvm. A curve of v_c vs. i_c is plotted. The slope of this curve is R_{22}. A family of curves may

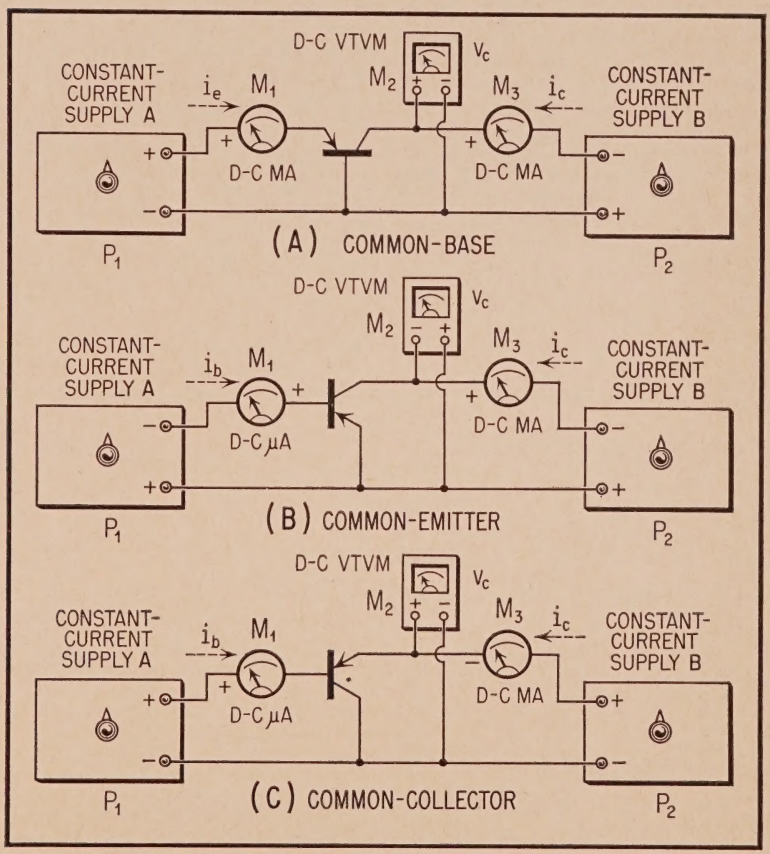

Fig. 3. Setups for Checking R_{21} and R_{22}.

be plotted for various constant values of i_c.

In the common-emitter (Figure 3B) and common-collector (Figure 3C), collector current i_c is varied while holding base current i_b constant. The resulting collector voltage v_c is indicated by the vtvm. A curve of v_c vs. i_c is plotted. The slope of this curve is R_{22}. A family of curves may be plotted for various constant values of i_b.

Reverse Transfer (Feedback) Resistance R_{12}. The test circuits are shown in Figure 1. In the common-base circuit (Figure 1A), collector current i_c is varied while holding emitter current i_e constant. The resulting emitter voltage v_e is indicated by the vtvm. A curve of i_c vs. v_e is plotted. The slope of this curve is R_{12}. A family of curves may be plotted for various constant values of i_e.

In the common-emitter (Figure 1B) and common-collector (Figure 1C), collector current i_c is varied while holding base current i_b constant. The resulting base voltage v_b is indicated by the vtvm. A curve of i_c vs. v_b is plotted. The slope of this curve is R_{12}. A family of curves may be plotted for various constant values of i_b.

Forward Transfer Resistance R_{21}. The test circuits are shown in Figure 3. In the common-base circuit (Figure 3A), emitter current i_e is varied while holding collector current i_c constant. The resulting collector voltage v_c is indicated by the vtvm. A curve of v_c vs. i_e is plotted. The slope of this curve is R_{21}. A family of curves may be plotted for various constant values of i_c.

In the common-emitter (Figure 3B) and common-collector (Figure 3C), base current i_b is varied while holding collector current i_c constant. The resulting collector voltage v_c is indicated by the vtvm. A curve of v_c vs. i_b is plotted. The slope of this curve is R_{21}. A family of curves may be plotted for various constant values of i_c.

Relationships between Parameters. For

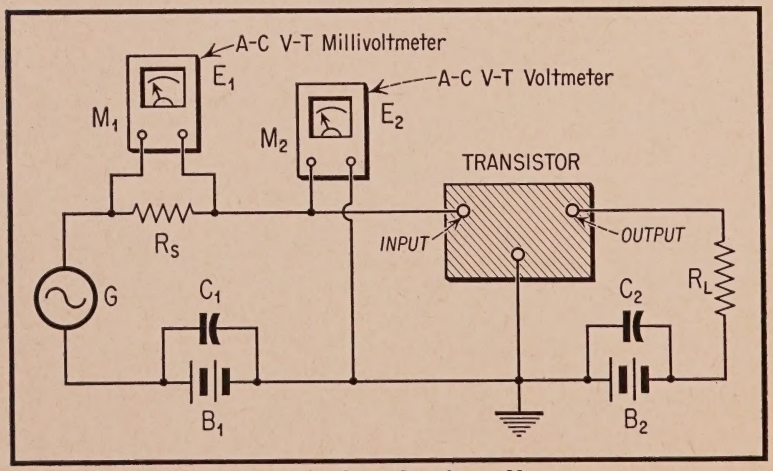

Fig. 4. Circuit for Input Impedance Measurement.

the common-base configuration, $R_{12}=r_b$; therefore, $r_e=R_{11}-R_{12}$. Also, $R_{21}=r_b+r_m$, and $r_m=ar_c$. Alpha (a) is the slope of the curve i_c vs. i_e for constant v_c. For the common-emitter configuration, $R_{12}=r_e$; therefore, $r_b=R_{11}-R_{12}$. Here, $R_{21}=r_e-r_m$, and beta (B) is the slope of the curve i_c vs. i_b for constant v_c. For the common-collector configuration, $R_{12}=r_c$; therefore, $r_e=R_{22}-R_{12}$. Also, $R_{21}=r_c(1-a)$. Here, beta (B) is the slope of the curve i_e vs. i_b for constant v_e.

Basic A-C Measurements

The resistance values obtained by d-c measurements in the manner just described will be approximately correct for impedances at low audio frequencies. However, the input and output impedances and amplification factor undergo significant changes at higher frequencies. In the common-collector circuit, for example, when the load resistance is constant, R_{11} often shows a reduction of 90 percent between 100 cycles and 50 kc with conventional audio-type transistors, and voltage amplification may undergo an 8 per cent decrease between 10 and 50 kc.

Frequency-sensitive parameters other than the internal resistances of the transistor include alpha, beta, and collector capacitance. In one high-frequency transistor, power gain decreases from its low-frequency value (45 db at 1.5 Mc) to unity at 132 Mc.

When a transistor is to be employed at high frequencies, its input and output impedances, which are extremely important in circuit design, should be measured under a-c conditions, preferably at the actual frequency of operation.

Figure 4 illustrates one method of determining transistor input impedance (Z_i) in terms of alternating voltage and current. The configuration may be either common-base, common-emitter, or common-collector as required, hence the transistor is shown here as a block with three terminals. Batteries B_1 and B_2 represent the d-c bias voltages required by the input and output electrodes, respectively, to set the transistor operating point. A low-impedance generator, G, supplies a test-signal voltage at the operating frequency and this voltage alternates between peak values slightly higher and lower than the d-c voltage of B_1. Thus, the input signal to the transistor fluctuates over a small increment. Usually, this generator is an a-f or r-f signal generator having low output impedance. High capacitances, C_1 and C_2, bypass the d-c sources at the generator frequency. The a-c input voltage (E_2) is indicated by a high-impedance vtvm, M_2. An a-c vacuum-tube millivoltmeter, M_1, is shunted by resistance R_s which is much lower than the input impedance of any transistor to be tested. Its deflection therefore is proportional to the a-c signal-input current. Thus, meter M_1 effectively is an a-c milliammeter. The a-c input current is equal to E_1/R_s, where E_1 is the deflection of meter M_1.

The transistor is terminated in the normal load impedance, R_L, into which it is to operate in the circuit to which it will be applied. This is a necessary condition, since input impedance is sensitive to load impedance.

Since $Z=E/I$, the input impedance Z_i of the transistor is calculated from the deflections of M_1 and M_2. Thus, $Z_i=E_2/(E_1/R_s) = (E_2R_s)/E_1$; where R_s and Z_i are in ohms, and E_1 and E_2 in volts.

Figure 5 illustrates a similar 2-meter method of determining transistor output impedance (Z_o). As in the preceding example, batteries B_1 and B_2 represent the d-c bias voltages required by the input and output electrodes,

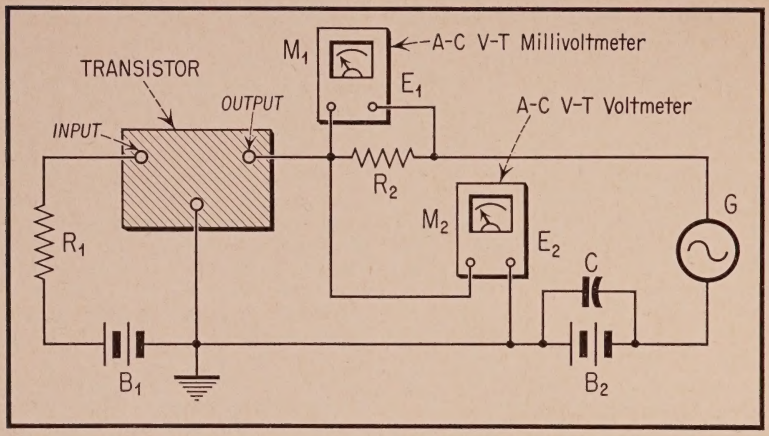

Fig. 5. Circuit for Output Impedance Measurement.

respectively, for the desired operating point of the transistor. The low-impedance generator, G, supplies a test-signal voltage which alternates between peak values slightly higher and lower than the d-c voltage of B_2. Thus, the test signal applied to the output electrodes of the transistor fluctuates over a small increment. Resistor R_1 provides an input impedance path equal to the impedance out of which the transistor will operate in the circuit to which it will be applied. High capacitance C bypasses d-c source B_2 at the operating frequency. The a-c test voltage (E_2) is indicated by a high-impedance a-c vtvm, M_2. An a-c vacuum-tube millivoltmeter, M_1, is shunted by resistance R_2 which is much lower than the output impedance of any transistor to be tested. Its deflection therefore is proportional to the test-signal current. As in the preceding example, meter M_1 effectively is an a-c milliammeter. The a-c test-signal current is equal to E_1/R_2.

Using Ohm's Law, output impedance is calculated from the deflections of M_1 and M_2: $Z_o = E_2/(E_1/R_2) = (E_2R_2)/E_1$; where R_2 and Z_o are in ohms, and E_1 and E_2 in volts.

It should be noted that considerable care is required for successful measurements using the schemes illustrated by Figures 4 and 5, especially at radio frequencies. To begin with, meter M_1 in each instance is operated above ground, hence it should be of the self-contained battery type to avoid power line complications. All leads in the test circuit must be as short as practicable, but stray capacitances and interaction due to close spacing of instruments must be avoided. The shunt resistor (R_s in Figure 4; R_2 in Figure 5) must be non-inductive. The load (R_L in Figure 4) and the equivalent driving impedance (R_1, Figure 5) must be the identical impedance devices which will be used in the final circuit, although they are represented here as simple resistances. The d-c electrode bias currents must be set exactly to the desired levels (by adjustment of B_1 and B_2) to maintain the transistor at the desired operating point. A d-c milliammeter or microammeter, inserted temporarily in series

with B_1 and then B_2, may be used for this purpose.

Use of Bridge

The resistive and reactive components of transistor input and output impedances may be evaluated separately by conventional a-c bridge methods. The input or output circuit of the transistor constitutes the unknown arm of the bridge.

For this purpose, the transistor must be dc-biased in a manner somewhat similar to the application of a polarizing d-c voltage to an electrolytic capacitor or iron-core choke during bridge measurements. The bias currents must be measured accurately with suitable d-c milliammeters or microammeters and set to the desired operating level. Both the input and output electrodes of the transistor should be dc-biased during the measurement. Suitable choke coils or isolating resistors must be employed to block the flow of the a-c bridge currents into the bias supplies. The bridge signal must be held low enough to prevent exceeding either the normal operating voltage or peak inverse voltage ratings of the transistor.

Amplifier Impedances

Figure 6 shows a simple setup for checking the input impedance (Z_i) of a transistorized amplifier. In this arrangement, the amplifier is terminated in its normal load impedance, R_L. The latter may be the actual load device, such as a loudspeaker, or may be an equivalent resistance.

The test signal is supplied by a suitable signal generator or test oscillator. A calibrated, non-inductive, variable resistor (R) is connected in series with the generator and the amplifier input terminals. An a-c vtvm is arranged with a spdt switch (S) to read signal voltage e_1 before the resistor (Position a) or e_2 after the resistor (Position b).

In operation, switch S first is thrown to a and voltage e_1 observed. The switch then is thrown to b, and resistor R is adjusted carefully to set e_2 equal exactly to $\frac{1}{2}e_1$. At this point, the resistance setting of R equals

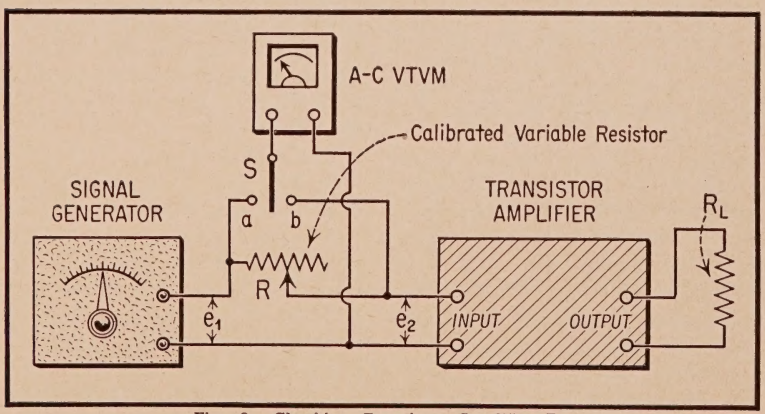

Fig. 6. Checking Transistor Amplifier Z_i.

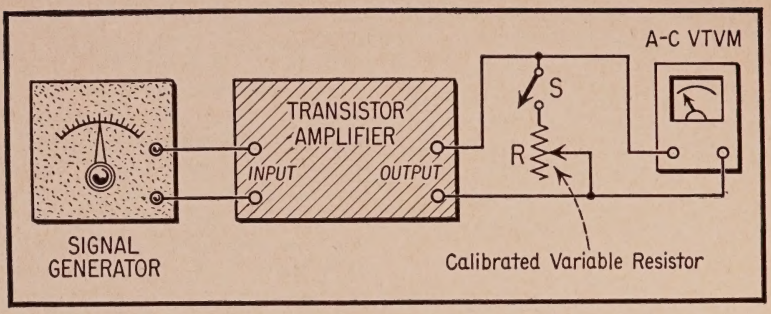

Fig. 7. Checking Transistor Amplifier Z_o.

the input impedance of the amplifier and may be read directly from the resistor calibration. If the resistor is not direct-calibrated, it may be removed from the circuit and its resistance setting measured with an ohmmeter or bridge. Throughout the measurement, the test voltage must be held to an amplitude low enough to prevent overdriving of the amplifier The test may be repeated at a number of frequencies to determine the variation of Z_i with frequency.

Figure 7 shows a similar circuit for measuring the output impedance (Z_o) of a transistorized amplifier. In this arrangement, the signal generator or test oscillator supplies a signal voltage to the input of the amplifier. The amplitude of this voltage must be restricted to prevent overdriving the amplifier. A calibrated, non-inductive, variable resistor (R) is connected to the amplifier output terminals through a spst switch (S). An a-c vtvm indicates the amplifier output voltage.

The output voltage (e_1) is read with switch S open. The switch then is closed and resistor R adjusted to set the voltage to a new level e_2 equal exactly to $\frac{1}{2}e_1$. At this point, the resistance setting of R equals the output impedance of the amplifier which may be read directly from the resistor calibration. If an uncalibrated resistor is employed, it may be removed from the circuit and its resistance setting checked with an ohmmeter or bridge.

When checking an amplifier employing a power-transistor output stage, resistor R must be rated to dissipate safely at least twice the expected power output of the amplifier.

Additional, detailed data on transistor impedance measurements may be found in the following sources.

1. **Principles of Transistor Circuits.** Richard F. Shea, Editor. (John Wiley & Sons, Inc.; New York, N. Y.). pp. 485-503.

2. **Transistors, Theory & Practice.** Rufus P. Turner. (Gernsback Library, Inc.; New York, N. Y.). pp. 109-121.

3. **Transistor Characteristics at Low and Medium Frequencies.** L. J. Giacoletto. TELE-TECH & ELECTRONIC INDUSTRIES, March 1953. p. 97.

4. **Surface-Barrier Tranistor Measurements and Applications.** Roland J. Turner. TELE-TECH & ELECTRONIC INDUSTRIES, August 1954. p. 79.

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WANTED — IRE proceedings from 1952 and older. R. Davidson, 87-10 204 St., Holliswood 23, N. Y.

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SELL OR TRADE — GE 250 portable scarcely used, homo-built electronic high voltage photoflash in carrying case, including Sylvania R4330 tube, less reflector only. Want Leica copying (BOOWU) attachment for 3c. A. Martin, 406 Queens Ave., Massapequa, L. I., N. Y.

SELL OR TRADE — BK-401 soundmirror tape recorder, mechanically ok, cabinet needs touching up. Need 10 w. FM transceiver in 155 mc range, need not be in working cond. Herb Ailing, Strasburg, Ohio.

WANTED — Instruction manual for McMurdo-Silver 909 sweep gen., range 2-226 mc. or permission to photostat. Mason DeCamillis, 325 Shadowlawn Dr., Inkster, Mich.

SELL OR TRADE — Gonset G66B unused; Almac PMR6 with 12 v. supply; Hallicrafters SP44 pan adaptor, very clean; Leece-Neville unit complete for 6 or 12 v.; Bendix T12 trans. 100 w. Need Ranger, must be clean. Samuel Lieberman, 130-29 228th St., Laurelton 13, Queens, N. Y.

FOR SALE — Over $600 worth of tubes, condensers, resistors, speakers, transformers, 40 Sams Photofacts in binders, NRI multitester, models No. 34 sig. tracer, 88 sig.gen., 69 tube tester, l. n., $175 complete. Robert Garrison, 14800 Martell Ave., San Leandro, Calif.

FOR SALE — Hallicrafters R-46 speaker, A-1 cond., $10; Taco 400 ohm open wire line, 100 ft. package roll, $2.50. John J. Oskay, 70 Senior St., New Brunswick, N. J.

FOR SALE — Heath LP-1 pattern gen. with factory added sync terminal and lead same as on LP-2, factory checked, unused, $22.50. E. Hoornstra, 722 E. Spruce St., Sault Ste. Marie, Mich.

SELL OR TRADE — Heath TS-3 sig. gen and marker, assembled but never used, $35 or trade for good used 2-speed tape recorder, working or not. Donald Rockwell, R 1, Box 193-A, Goshen, Ind.

FOR SALE — Matched pair of Thordarson Hi-Fi push-pull transformers, T15A74 and T15S90, complete with pictorial and schematic circuit, 15 w. output, inverse feedback. ±1 DB, 40-15,000 cycles with bass boost, $9 for pair. Vincent Pellettieri, 5523 31 Ave., Woodside 77, L. I., N. Y.

WANTED — Simpson 488 field strength Meter. State price and cond. V & M Radio & TV Service, Box 141, New Roads, La.

SWAP — PA system, disc recorder, geiger counter, "bug" or various parts for electric train set or photographic equip. R. F. Graf, 215 W. 92 St., New York City, N. Y.

WANTED — Lampkin 105 freq. meter; 205 modulation monitor; Measurements Corp. microvolter model 80; 30-50 mc mobile units complete with cables and control heads. State lowest cash price and cond. George Tate, Artillery Rd., RFD 4, Taylors, S. C.

SELL OR SWAP — Unused 1951 Philco push-button auto radio, never installed; Sunbeam shavemaster. What have you? M. Gianfrocco, 1 Bell St., Providence 9, R. I.

SELL OR TRADE — 4" reflector telescope, with tripod, altazimuth mount, 2 eyepieces for magnification of 64x and 192x, and 7 power finder scope. Want Hallicrafters rcvr. L. Suchow, 1915 University Ave., New York 53, N. Y.

FOR SALE — Browning RJ12 tuner and power supply; Bogen DB20DF amplifier; UTC LS-33 high level matching transformer. Donald Keiser, Gladbrook, Iowa.

FOR SALE — Riders 2 thru 7, l. n., $8 each. Local preferred. James Daniele, 449 4th St., Elmont, L. I., N. Y.

FOR SALE — Hammerlund HQ129X rcvr, $100; Precision E-200-C sig. gen., $30; Precision 954 tube and set tester, $65; vibrator power supply 6 v. input, 300 v., 100 mils, $10. All in good cond. M. Vassallo, 99 Greenpoint Ave., Brooklyn, N. Y.

FOR SALE — Heath TS-4 sweep gen., $40, and 0-10 5" scope, $55. Probes $4 extra; Motorola 7" TV, needs repair, $10; Dumont 17" TV console with FM, $35, needs repair. All F.O.B. Donald E. Zeitz, 247 Conant St., Hillside 5, N. J.

FOR SALE — RCA TV eye camera, excellent cond., $375; RCA ATJ TV camera as pictured on page 114 August C. Q. mag., $295, includes tripod, power supply, monitor etc. T. V. Labs, 111 Main St., Waterville, N. Y.

FOR SALE — Radio & TV tubes; GE elec. foot-warming pad, $3, Blonder-Tongue 4-tube automatic booster HA-1L, $10. Andrews, 740 Maple St., Bethlehem, Pa.

FOR SALE — Mon-Key, $15; Millen 90700 variarm VFO, $20; 838 tubes, $3 each; TS-117-GP test set, $15. Robert Roske, 306 Prospect St., Cambridge, 39, Mass.

SELL OR TRADE — 2 sheets unpainted & unpunched aluminum 101/2" x 19" x 1/8", and 2 sheets of 153/4" x 19" x .091", $13 or trade for 115 v. AC isolation transformer 125 w. Ray Bohnert, Medford, Wisc.

FOR SALE — Past issues of Electronics, QST, CQ, and Radio/TV News, 15c each, plus shipping; Meissner 9-1090 sig. shifter, $37.50; 10m ST-203-A xmtr, $37.50. Roswel Electronics, 306 Prospect St., Cambridge, Mass.

WANTED — 110 VAC and 12 v. power supplies for BC-669-B, or diagram of the 12 v. DC supply. William Hansen, 165 Silverbrook, Niles, Mich.

WANTED — For cash, UTC S48, S35, and S36, reasonable. Have Heath gen. TS 1A for sale, $35. A. R. Tuttle, 25010 Ford Rd., Dearborn, Mich.

FOR SALE — Drake 900 soldering gun, 135 w., l. n., only $6.50 cash. T. J. Englert, Jr., 1601 Frances St., New Orleans 17, La.

TRADE — Unused 16EP4A TV tube for a Precision or equal tube tester and VOM both in working cond. C. W. Bently, Box 236, Talent, Ore.

WANTED — HW Sams, any amount, parts or complete set if reasonably priced. Will pay postage. Jack's Shop, R 1, Lewisburg, Pa.

SELL OR SWAP — Heath sweep gen. TS-1 for condenser tester of like value. Joseph Blahoves, 134 Berry St., Dover, N. J.

SELL OR TRADE — Hearing aids; metal locator; duplicator. Want transistors; tube tester. John Haynes, Doe Run, Mo.

WANT — Heath A-7E or A-7D amplifier, kit preferred, late model, new cond. Cash or trade. T. Ferguson, 171 E 91 St., New York 28, N. Y.

FOR SALE — Two model 79 Webster wire recording mechanisms. Both in A-1 cond. Best offer takes either or both. G. C. Hologa, Winchester, Wis.

SELL OR TRADE — Have Vomax, Weston Master 2, Riders 12, Photofact 1, 2, 4. Want short wave rcvr. L. Putnam, Woodward, Iowa.

FOR SALE — Perfect color 156GP22 pix tube. Make offer. Ray Feerick, 1376 Crosby Ave., Bronx 6, N. Y.

FOR SALE — Unused Vol. 1 NRI radio book, $12.50; Riders 1 to 5 abridged and 6 to 15 (Vol. 12 missing), $35 plus postage. Chas. J. Morris, 620 Frame St., Denton, Texas.

WANTED — Two-way radio for truck, 50-mile limit; also PA amplifier. Forest Donaldson, Slayton, Minn.

WANTED — RCA scope model WO-55A. Botbyl Radio Shop, 1009 Sophia St., Muskegon, Mich.

SWAP — Need tube tester. Have A elim. and battery charger, meters, tubes, parts; 16" console TV in working cond. Sam Berenblum, 417 Greenwich Ave, Greenwich, Conn.

WANTED — 10-15 hp Evinrude or Johnson outboard motor A-1. Have RCA 36-A gen. never used, FS meter, Rimco dynalyzer, Dumont 274 scope or ? G. E. Howarth, 216 1 Ave. East, Oskaloosa, Iowa.

WANTED — Q multiplier and mobile converter, 3-30 Mc. Will swap 829B's; Wilcox CW-3; or 3" meters. Henry Wemple, Norton Rd., Vernon Center, N. Y.

FOR SALE — Hallicrafter rcvr. model 38, good cond., $20. Leroy Tresselt, 3122 N. George St., Franklin Park, Ill.

SELL OR TRADE — Radio and S F magazines for cash or parts, etc. V. Johannes, 1541 Metropolitan Ave., Bronx 62, N. Y.

WANTED — 3" Heathkit scope; also tube checker, 625 Eico or equal. Will swap for ham gear or test equip. Lee Terry, Sr., 1914 Ballinger Rd., Seattle 55, Wash.

SWAP — Bell 3 speed hi-fi tape recorder, volume and tone controls, fast wind and rewind, erase interlock, response 40 to 15,000 cps. Want hi-fi power amplifier and AM-FM tuner in excellent cond. H. Piller, 451 Thieriot Ave., Bronx 72, N. Y.

WANTED — Service Notes and diagrams of the G.E. rcvr., type E-155. State price and description. Dan L. Stevens, 34 Yale Sq., Morton, Pa.

WANTED — Alliance H1R-2 rotator. State price. Glen Johnson, Seymour, Tenn.

FOR SALE — Precision WW resistors, 3485, 5400, 20,000, 5,000, 750, 1600, and 2215 ohms, 1% tolerance, 50c each. A. Himmelbaum, 141-55 85 Rd., Jamaica 35, L. I.

WANTED TO BUY — GE BM-1A FM freq and modulation monitor with power supply. State price and monitor's present frequency. F. C. Hervey, Chief Engineer, WLFM, Lawrence College, Appleton, Wis.

FOR SALE — Outdoor business neon sign, metal for 4 lines of lettering with transformer 6" x 2" x 10" deep. Best offer, local. T. Wasek, 40 Ackerson Ave., Pequannoc, N. J.

WANTED — Hallicrafters SX-17 rcvr. Cash or trade. Norman Carignan, 3 Curtis St., Providence 9, R. I.

WANTED — Small portable disc recorder in working cond., any make or model. D. Teague, Box 964, Hurley, N. Mex.

SELL OR TRADE — "Galxay" SF mag. Nov. 51-Nov.57, except 1 issue; "Astounding" SF, Oct. 49-June 57, complete except 5. Want good communications rcvr., National, Hallicrafters, or Hammurlund. Stephen Swerling, 132 Bloomingdale St., Chelsea 50, Mass.

SELL OR TRADE — Back issues of Service Technician and Service Dealer; also misc. books. Send for list. Need Technician Digests prior to set 31 (March 1955). Farmer's Radio & TV Service, Brady, Texas.

WANTED — Heath AV-3 audio VTVM. Jerome Mendel, 938 Kenyon Ave., Plainfield, N. J.

WANTED — Sams Photofacts in good shape from No. 1 through 150. Must be in this general territory. Will pay cash or trade test instruments. Thompson's Radio & TV, Box 330, Fayetteville, Tenn.

WANTED — 2 matching Hi-Fi cabinets 26" max. width, with or without speakers. Will trade used TV in good working cond. or Sams, or Riders for same. Arch Campbell, 78 Main, Dublin, Pa.

SELL OR TRADE — Heath DX-35 xmitter, VFO $90; Hallicrafters SX-99 rcvr., $100; Simpson: 269 VOM $75, tube tester $75, sig. gen. $75. All A-1 cond. Want DX-100 and SX-100 or equivalent. Walter Conway, 3229 Maddux Dr., Palo Alto, Calif.

FOR SALE — Sound-Scriber portable model PCRICBC, $50; Leeds & Northrup standard cell, $10; GE fil trans pri 115 v, sec. 5 & 5v, kva. 065, ins. 12 kv. $10; United choke LS-92, $10. R. Bronson, 252 Mateo Way, St. Petersburg 4, Fla.

FOR SALE — (N. Y. Metropolitan Area) Components including makings of 300 w. fone xmitter: meters, chokes, xformers, 6 v. vibropack, many small parts, tubes, etc. Buy singly or all, very cheap. Diamond, 550 W. 20 St., New York, N. Y.

TRADE — Japanese military xmitter, rcvr., and hand gen. Rcvr. range 400-6,000 kc, transmitter range 600-5,000 kc; VFO or crystal oscillator, CW and phone for tape recorder. Wesley W. Harris, R 5, Box 2325, Bremerton, Wash.

FOR SALE — Heath FM-3 tuner, factory calibrated. Never used. Ship postpaid $30. Ben Marconi, 120 Gatling Pl., Brooklyn 9, N. Y.

FOR SALE — Zenith H500 transoceanic, $65; Granco UHF converter, $10; Heathkit TS-2 sweep gen., $20. All l. n. Might trade for LF or VHF aircraft rcvrs. R. J. Faulstick, 4800 Kolmar Ave., Dayton 3, Ohio.

FOR SALE — RCA BC & SW radio AC; AC-DC table radios: Temple BC & SW, Motorola, Bendix, $25 for the lot, all perfect. Local only. Thomas Byrne, 331 Calhoun Ave., Bronx 65, N. Y.

WANTED — RME VHF 152-A or B in good cond. W. J. Wilson, 418 Grandview Ave., Indiana, Pa.

SELL OR TRADE — Meissner 8C FM tuner, $20; Heath V7A VTVM, $18; AW-1 audio wattmeter, $20; GE 260 portable radio, $25. Want Magnecord low level mixer, 10" ext. arms. Gene Blash, 1839 So. 12 Ave., Maywood, Ill.

FOR SALE — Globe Chief built by owner, perfect cond. Most reports 599X, $55. Can't ship, will demonstrate on request. Herman Nied, 57 Patton Blvd., New Hyde Park, N. Y.

SWAP — Philco model 61 12.5 amps ½ ton window air conditioner used very little for good color bar gen. Vincent Iavarone, 1218 Leland Ave., Bronx 72, N. Y.

FOR SALE — Tubes and surplus equip. Send 2c stamp for list. Bill Storey, 254 Fairgreen Ave., Youngstown 4, Ohio

WANTED — TV sets, 14", 16", 17", in good or repairable cond. in Brooklyn Area. State asking price and make. Sal's Television Servicing, 1658 East 55 St., Brooklyn 34, N. Y.

FOR SALE — Precise 630 sig. gen., $44; as is 10" TV chassis, $4.50 and 12" chassis, $6.50. H. Bell, 3917 Ely Ave, New York 66, N. Y.

WANTED TO BUY — Tuner for CBS Sky-King TV model 10-100 same as Silvertone 117-17, uses a 6BC5 RF and 6V6 osc-mixer. Albert C. Hart, Certified Radio Service, 207 N. Raymond St., Griffith, Ind.

WANTED — Hammurlund HQ 129X rcvr with speaker; Spanish record course. Have Hallicrafter S40A rcvr. Norman McHale, 77 Turner Ave., Buffalo 20, N. Y.

SWAP OR SELL — Projection TV with screen; Heath SG-6 sig. gen.; RCA wire recorder; Bromeco 10 m mobile xmitter; other misc. radio equip. Want all types ham and ham test equip. Selwyn Wynstock, 5002 S. Lawler, Chicago 38, Ill.

WANTED — Low to medium priced communications rcvr.; also slide projector. State price and cond. Frank Gibes, 4941 Crystal St., Chicago 51, Ill.

WANTED — One or two man Radio & TV Shop in North Carolina, eastern part preferred. V. Dunne, 1526 Randolph Ave., Greensboro, N. C.

FOR SALE — GE synchro rcvr. and synchro xmitter, $10 for both. Aram J. Barsoomian, 21 Porter St., Watertown 72, Mass.

FOR SALE — HQ 150 rcvr. in perfect cond. Sacrifice $225. No shipments. Andy Rogers, 5 Stuyvesant Oval, New York 9, N. Y.

FOR SALE — Zenith FM-AM Super Symphony table model 725 radio rcvr. in excellent working cond. Best cash offer. D. Landesberg, 179 Marcy Ave., Brooklyn 11, N. Y.

WANTED — RCA Pict-O-Guide Vol. II; Jackson selenium rectifier tester. L. M. Mick, 202 N. Peoria Ave., Dixon, Ill.

FOR SALE — National NC-173 rcvr.; Meissner EX sig. shifter; BC-610 exciter deck; BC-610 PA coils and misc. parts. Want to buy Supreme AF-100 xmitter. E. L. Felder, Tylertown, Miss.

FOR SALE — Heath: G-5 sig. gen., $14.75; T-2 sig. tracer, $19.50; LP-1 linearity pattern gen., $22.50; Eico 360 sweep gen., $22.50; l. n., with manuals and leads Weiss Radio-TV Service, 1427 Glencoe St,, Denver 20, Colo.

FOR SALE — Complete Radio-TV business, stock, equipment, tools, misc. Net value $4,000, will sacrifice at once. For complete inventory write Eugene Byram, Box 128, DeLeon Springs, Fla.

TRADE — Stromberg-Carlson AM-FM 11-tube radio chassis, 550-1750 kc, 40-50 mc, Electro-Voice 606-20 mike. Need SW rcvr, code oscillator. David DeCobert, 609 Henrietta Ave., Gillespie, Ill.

TRADE — Dumont 241 lab. oscilloscope. Want recent Hickok tube tester. Prefer Boston area. Edward Withey, 22 Anselm Ter., Brighton 35, Mass.

SELL — Unused Rek-O-Kut TR-12-H recording turntable, with M-12 lathe and 8-ohm cutter, $150; DeJur PTR-90 tape recorder, warranty, reg. card, and dynamic mike, $225; Shure 55S and E-V 664 mikes, choice, $40; 17" professional lathe, slightly used, less head, $75. All items FOB. John T. Moore, Box 63, Seneca, S. C.

WANTED — Webcor tape recorder in any cond.; good communications rcvr. with xtal filter or Q multiplier; Heathkit test equip. complete with manuals; Sams Photofact folders. All for cash or trade. Wood Radio & Television Service, 213 Springer Dr., Coraopolis, Pa.

WANTED — Tubes: TV, receiving, transmitting, power, etc.; also test and communications equipment. Surplus acceptable. Cash or swap. Lou Dollin, 172 Washington St., New York 7, N. Y.

FOR SALE — Century "In Circuit" condenser checker, $20. S. Cutler, 1954 Unionport Rd., New York 62, N. Y.

FOR SALE — Hickok 610A sig. gen. used very little, $75; Simpson genescope 480, excellent cond., all cables, instructions, $200, or $250 for both. Anderson L. Lowe, 717 Devon Dr., Greensboro, N. C.

TRADE — 7" Sylvania oscilloscope, excellent cond plus cash for ham rcvr. Gonset 2-meter converter, $25; Heath TV alignment gen., $20. Want used rcvrs. any cond. for cash. Conrad Radio & TV, 12908 Lorain, Cleveland, Ohio.

FOR SALE — Complete amateur station: Johnson Adventurer xmitter, Elmac PMR-6A mobile rcvr., Heath VFO, Dow-key coax. relay. All excellent cond., complete, $155 plus shipping. R. H. Will, 306 Willowbend Rd., Tonawanda, N. Y.

WANTED — For cash RCA TV Servicing course, 1953 or later. Don Meek, 210 N. Rock, Sheridan, Ark.

FOR SALE — 2 UHF converters, Regency RC 600, and all-channel 99; also 6AF4 and 2AF4 brand name tubes, all for $20. B. J. Laporte, Jr., 2285 Sere St., New Orleans 22, La.

WANT — To buy VTVM; 5" scope; tube checker, in working cond. or repairable. State make, cond. and price. Voldemars Rage, 1638 W. 6, Anderson, Ind.

FOR SALE — Pilot FM tuner in excellent cond., $20. Local deal only. Milton Wendroff, 2016 Avenue N, Brooklyn 10, N. Y.

FOR SALE — Heathkit A7-E amplifier with preamp, A-1 cond.; 45-rpm automatic record changer, holds 11 records in A-1 cond. Best offer cash or trade for ham gear. Will sell separately. Du-Wayne Bostow, Max, N. D.

WANTED — Regency FM televerter, Heath kit FM tuner and Miller reflex tuner. O. Zetlmeier, 1123 Woodycrest Ave., New York 52, N. Y.

WANTED — Tubes and ham gear. Any type or quantity tubes, rcvr, xmitter, etc., plus RTTY equipment. Setting up new ham station. Send list and details in first letter. Sy Denby, 78 Cortland St., New York 7, N. Y.

WANTED — Winchester 1897 shotgun and 40 w. modulator with power supply. Have for swap Evinrude 1 hp trolling motor, weighs 16 lbs. E. Harvey Cunningham, P.O. Drawer H, Rio Grande City, Tex.

SELL OR SWAP — Some QST's 1931 to '49 and Electronics, 1938 to '40, neither complete; collectors' items, i.e., old tubes and transcriptions (local only), Wasp, Super Wasp-coils, no power supplies. Want Johnson matchbox, S. W. R. bridge. I. Diamond, 130 Walnut St., Paterson 2, N. J.

SELL OR SWAP — Two sound powered U. S. Army hand set phones TS10-M. Were used for antenna installations — original cost, $29.95 each. Make offer. Ed Tatar, Box 76, Keisterville, Pa.

WANTED TO BUY — Usable Taylor T-55 xmitting tubes at reasonable prices. Advise quantity, price, and cond. Shad Whitt, Airport Dr., Princeton, W. Va.

FOR SALE — Heath TS-2 sweep, $20; SQ-1 square wave, $20; S-2 switch, $15; Eico 352 bar gen., $10; Simpson 20,000 o.p.v. VOM, $7; Terado inverter 6 v 60 w. vibrator, $14. Plus postage. R. Rogers, 28 Bellamy St., Boston 35, Mass.

WANTED — RCA 1 and 2 Pictoguide. Or will buy complete series 1, 2, and 3 if available. Advise cash price. John A. Fels, 801 Silver Spring Ave., Silver Spring, Md.

WANTED — Books: Servicing and Calibrating Test Equipment, Milton S. Kiver; Radio Receiver Servicing, John T. Frye; Repairing Television Receivers, Cyrus Glickstein. Must be reasonable. Also resistance decade Heathkit, or Precise ½% to 1% accuracy. Quote prices. R. Chlupsa, 45-56 189 St., Flushing 58, N. Y.

WANTED — Schematic for linear Equip. Lab., Video amplifier cathode ray oscilloscope, model HF-1; and Pierce School of Radio - TV, multitester, model 630P. Robert Wendel, 160-20 Grand Central Pkwy., Jamaica 32, L. I., N. Y.

WANTED — Link FM radio xmitter-rcvr. type 2365, also Leece 6 v. altnator. Edward C. Hogge, Bena, Va.

FOR SALE — GE 640 portable 3-way, $25; 16 mm 100 ft camera spools, 5c each. Cas, 85-61 66 Rd., Forest Hills 74, N. Y.

FOR SALE — BC-645 and 654; 12GP7 CRT; MR-3-10-20-75 rcvr.; Supreme 680 audio osc. A. Turturro, 146-26 No. Hempstead Tpke., Flushing 55, N. Y.

FOR SALE — Jackson TV62 sweep-marker gen. with cables and inst., A-1 cond., $150; Hickok 191X microvolter, $45. Val Obal, 4165 J St., Omaha 7, Neb.

FOR SALE — Complete Heathkit LP-1 linearity pattern gen., R.F., bars or dots, $25. Bill's TV Service, 25 Sylvan Pl., New Rochelle, N. Y.

FOR SALE — Heath TS-4 TV alignment gen. recalibrated by the Douglas Instrument Co. Make offer. Want good clean 8773 R.C.P. servishop instrument. Ritts Radio Service, 644 No. 7 Ave., Tucson, Ariz.

SELL OR TRADE — BC 224A rcvr., excellent cond., low voltage version of type BC 348 with same frequency coverage and features. Cash $40. Roland St. Louis, 209 Cresthill Ave., Clifton, N. J.

SELL OR TRADE — 4X5 Graphic, enlarger, printer, etc., $300 or ham equip. Local only. Joseph Schwartz, 742 New Jersey Ave., Brooklyn 7, N. Y.

WANTED — PA system complete with horns to run off 6 v. battery for mobile PA speaking. Bob's TV Ser., Box 37, Wabasso, Fla.

FOR SALE — BC-312 SW rec., 6 bands-1500 Mc to 1800 Mc, turn dial to change bands, 10" speaker in cabinet. Converted from 28V to 110VAC, $50. Spencer White, 162 Market St., Passaic, N. J.

FOR SALE — Meissner 9-1090 sig. shifter, $29; 1. n. Webster wire recorder 80-B 80A, needs repairs, $19; 2 Edison cylinder type phonographs; Bendxi MRT3 mobile FM transceiver, needs repairs, $19; SR-20 Hallicrafters, $49. All fob. Louis, 204 Charter St., Clarksburg, W. Va.

SELL OR TRADE — Heath AR-2; AT-1 modulator and mike; photography magazines and equipment. Need DX-100 and ham gear. Will deliver where possible. M. Feigenbaum, 21 Boothbay St., Hartford 12, Conn.

SELL OR TRADE — Best offers: Set of 2 Canon cameras with F2 50 mm and F4 135 lenses; 16" recorder-playback with 70 blank discs, 1. n. Bob Townsley, 5939 Almaden, Oakland 11, Calif.

FOR SALE — Tel Rad 18A freq. standard, 1000, 100, 19 kc., $20; NC-173 rcvr., matching speaker, $130; 32V3 converted from 32V2, $400. Want Collins 4:1 knob for rcvr. J. Taylor, Stanwood Rd., Mt. Kisco, N. Y.

SWAP — High grade telescope with extremely stable tripod, micrometer adjustment; 8 x 35 French binoculars; BC-348M; Heath AR-2 for ham equip. of all kinds. Kenneth G. Davis, R 4, Severn Ridge Rd., Annapolis, Md.

FOR SALE — Unused Port-A-Temp portable air conditioner in sealed factory carton, $35. Jack Fives, 2916 Rockrose Ave, Baltimore 15, Md.

WANTED — Weston 983 scope or something comparable. Pratt's Radio TV Service, 170 7 Ave., W. N., Kalispell, Mont.

WANTED — Mobile ham gear, 2 v. system, rcvr, xmitter, pwr supply, VFO, antenna, etc., in good shape. State price. Alan York, 35 Main St., East Hampton, N. Y.

FOR SALE — Pair Vocaline transceivers 12 v and 115 v, pair Ground Plane antennas, used less than 5 hours, all for $100; Gonset Tri-Band converter 6 v and noise clipper, A-1 cond., $25 fob. J. Y. Wilfong, R 1, Newton, N. C.

SWAP — Simpson 260 multimeter not operating, for pocket size multitester 2,000 ohms per volt on AC and DC. Seymour Needelman, 261 East 55 St., Brooklyn 3, N. Y.

FOR SALE — 630 TV 10", in 21" console, yoke, hi-volt transformer, CRT bracket, parts to convert to 21", $75 fob; Hallicrafters 16", GE 10", and Emerson 10", $25 each; Transvision 12" with FM radio, $30. Nick's Radio, 170 Wellington Rd., Elmont, N. Y.

SELL OR TRADE — Hallicrafters SX42, fair shape, $125, or trade for Hi-Fi, amplifier, and tuner. Herman Horn, R 1, West Lafayette, Ohio.

SELL OR SWAP — Rider's Vols 1 thru 13, $25 plus postage. Michael Hubans, 6303 Landover Rd., Hyattsville, Md.

FOR SALE — Photofact folders, 1-324 including two Photofact filing cabinets; $500 cash. Roy O. DeVoe, 7 Beaumont Circle, Madison, Wis.

FOR SALE — Heath DX-20 xmitter, excellent cond., with WRL modulator for fone and CW operation, $49 fob, or express collect. J. Richmond, 2 Hiawatha Rd., Boston 26, Mass.

WANT FOR CASH — Hallicrafters Sky Buddy S-19-R or SX 24 or 25. State cond. and price. Harry Register, 25-94 42 St., L. I. City 3, N. Y.

FOR SALE — Bendix police xmitter converted to 6 m, complete with PE 103 cables, control box, etc.; Webcor 2030-A Hi-Fi tape recorder, A-1 cond.; German Luger automatic pistol. Best cash offers. Ed Nicks, R 1, Box 169-C, Dubuque, Iowa

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FOR SALE — 2500 w power plant complete, in excellent cond., $195 fob; refrig. ser manifold, gauges, hoses, 2-1 tanks and misc. with tool box, $35, or used rcvr. Robert Schmauss, 3903 Swann Ave., Tampa 9, Fla.

FOR SALE — Complete radio control outfit, never used: ECE-T-11 transmitter, Bonner escapement, O.K. Cub .099 engine, "Gazistor" rcvr. with relay (built from kit) less tube and transistor, plus many extras, $40 cash postpaid. A. A. Saunders, 11 Daniel Dr., Bridgeport 6, Conn.

WANTED — Schematics and plans for converters for use with HQ129V rcvr. for all bands from 6 m, 2 m on down. John G. Morrice, 57 Rockaway Ave., Rockaway, N. J.

SELL OR TRADE — Rider's TV manuals 1 thru 5, 1. n., $7 each fob; RCA battery sig. gen., $10; Hickok 305A scope, $35; Heathkit scope, push-pull, $35. N.Denaro, 116-14 120 St., Ozone Park 17, N. Y.

SWAP — 93 lessons plus law course by American Extension School for course in either Radio, TV, Electronics, or short-wave rcvr. E. J. Arsenault, No. Oxford, Mass.

SELL OR TRADE — RCA mobile xmitter, carbon mike, 6 v. dynamotor 375 v. output at 250 mils. Interested in medium or low power xmitter; VFO; communications rcvr. N. Preston, 313 East Chicago St., Marceline, Mo.

FOR SALE — Hammerlund HQ129X all-band short-wave rcvr., excellent cond., $125. William Ungvarsky, 157 Hawthorne Ave., Yonkers, N. Y.

WANTED — Diagram for Espey 20K o/p multimeter. Sell RCA 17" 2-door console, $20; Granco UHF converter, $5. J. Leach, Box 336, Milton, Del.

FOR SALE — Rider's Volumes 2, 3, and 8; Rider's TV Vol. 2, 3, 4. Make cash offer or swap. G. Epstein, 200-27 46 Ave., Bayside 61, N. Y.

WANTED — PR-9 or similar type policalarm rcvr. covering 152-174 Mc. R. V. Weakley, 141 General St., Providence 4, R. I.

FOR SALE — Harvey-Wells TBS50D deluxe with VFI VFO and power supply, $100 plus shipping. Want SX42, 43, or equiv. Don H. Miller, 601 Harrison St., Taft, Calif.

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FOR SALE — Hammurlund HQ-129-X rcvr. in excellent cond., $125. Bill Burton, 1728 Peach Ave., Memphis 12, Tenn.

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FOR SALE — Complete 522 rack mounting 2-meter station, $37.50; 500 w band-switching 813 CW transmitter less power, $40; BC221 cabinet, condenser, and gears, $10. Audio freq. meter with 1000-10,000 cycle scales, $10. Eggensperger, 101 Christie St., Tenafly, N. J.

FOR SALE — 200 B G.R. variac, $6 and C G.R., $10; 420 A W.E. tweeter, $15. W. Zinsmeister, 146 N. 16 St., Bloomfield, N. J.

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